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(54) **GROUNDING BRUSH ASSEMBLY**

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(57) **ABSTRACT**

A grounding brush assembly includes a grounding brush having a support and a plurality of conductive fibers fitted inside the support. A brush fitting plate is connected with the support of the brush and includes a plurality of retention tongues configured to retain the support of the brush, a radial portion, an annular flange extending from the radial portion and spaced radially outwardly from the retention tongues. The fitting plate also includes a plurality of through-openings, which each extend through the radial portion and through the flange, and at least one local deformation formed on the flange of the fitting plate and extending radially inwardly.

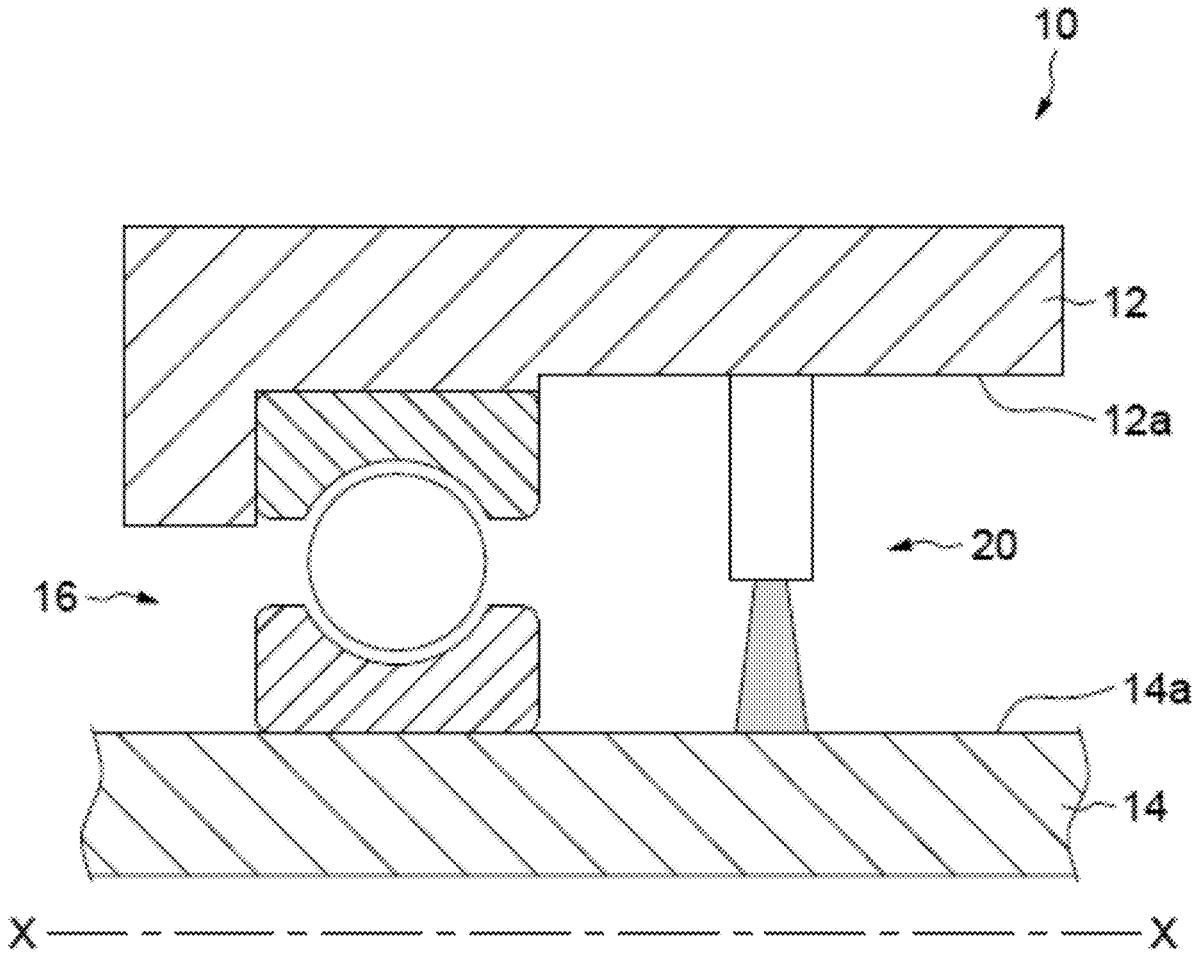


FIG. 1

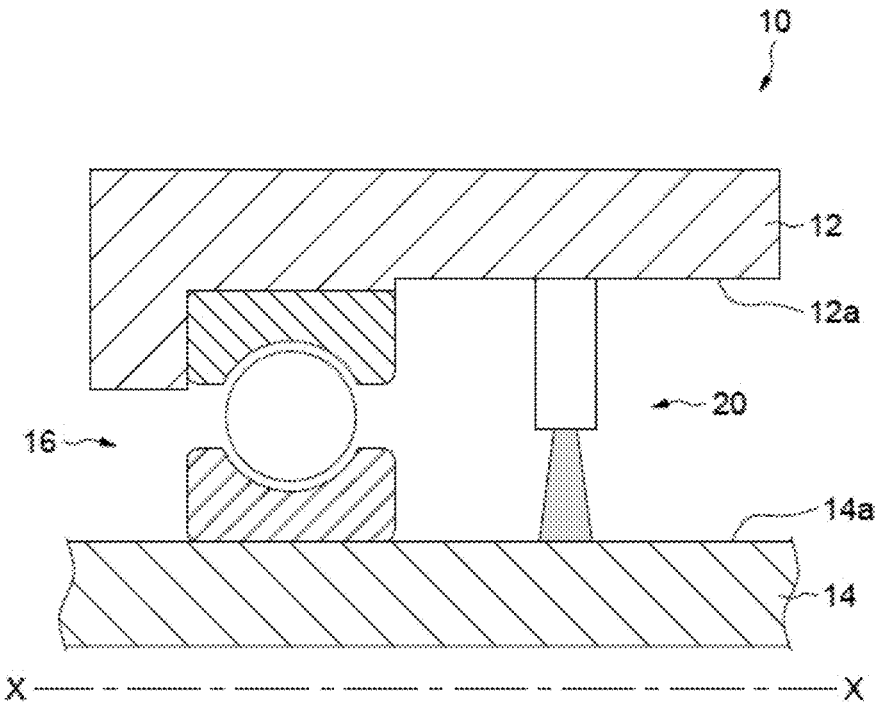


FIG. 2

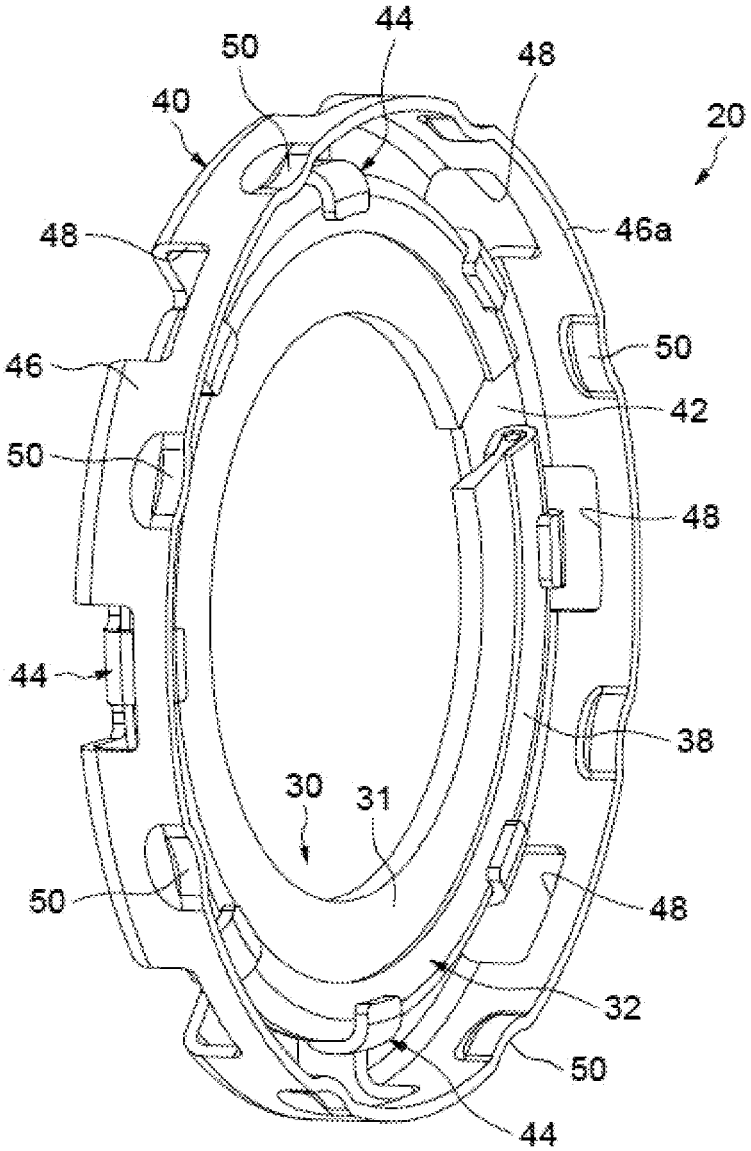


FIG. 3

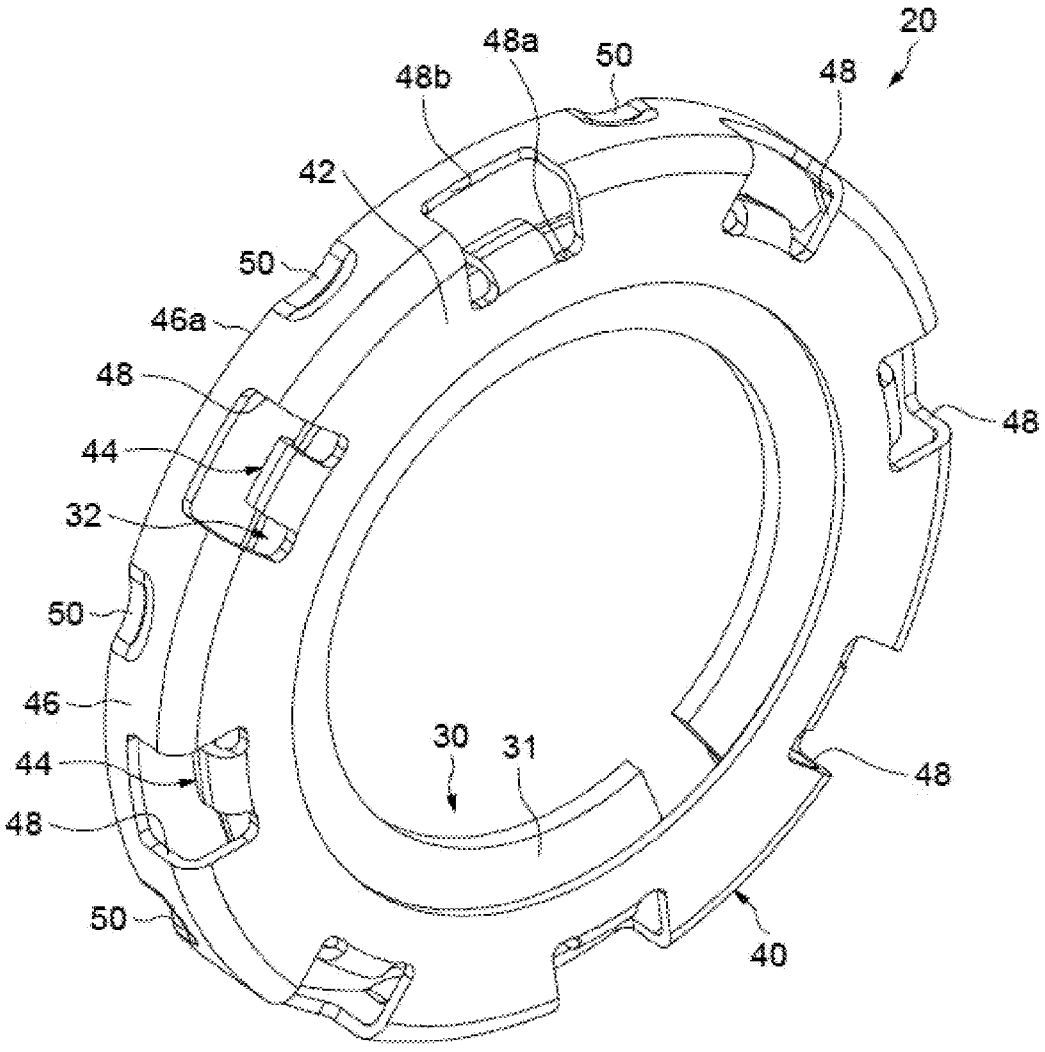


FIG. 4

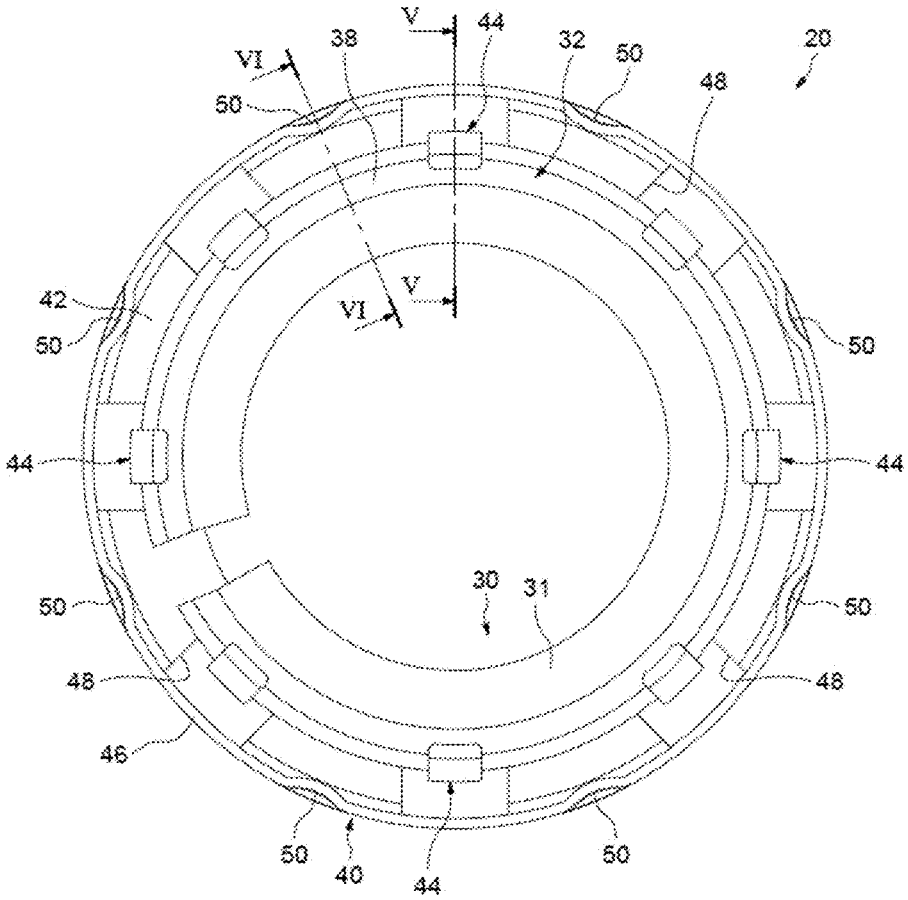


FIG. 5

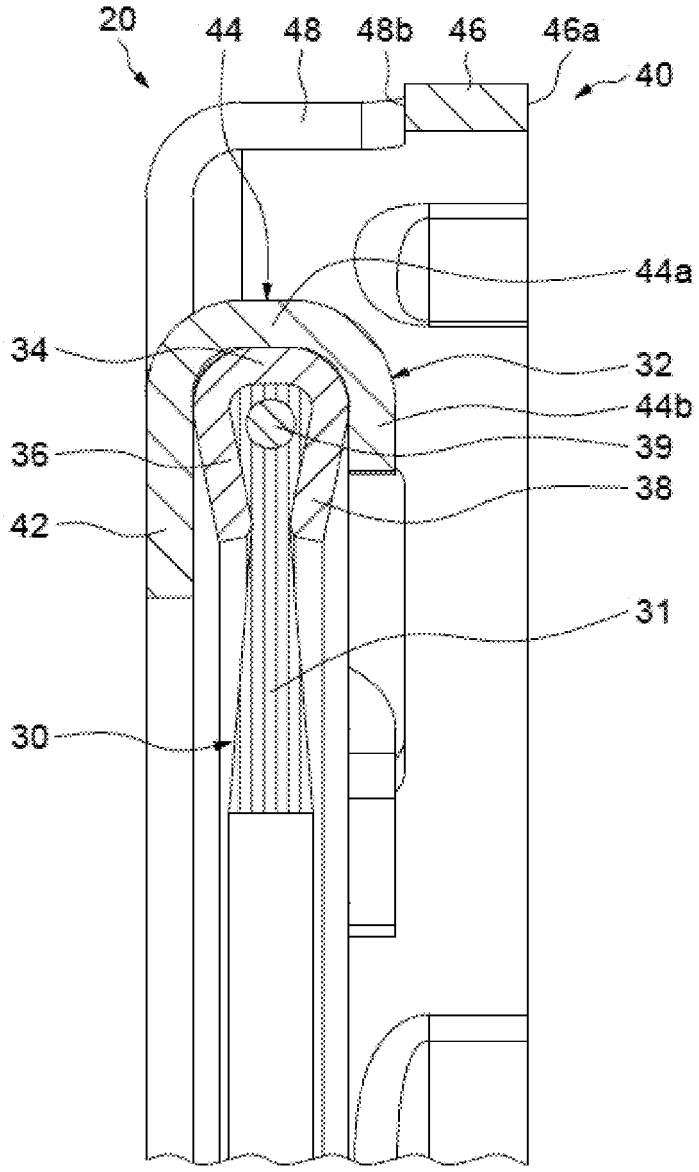


FIG. 6

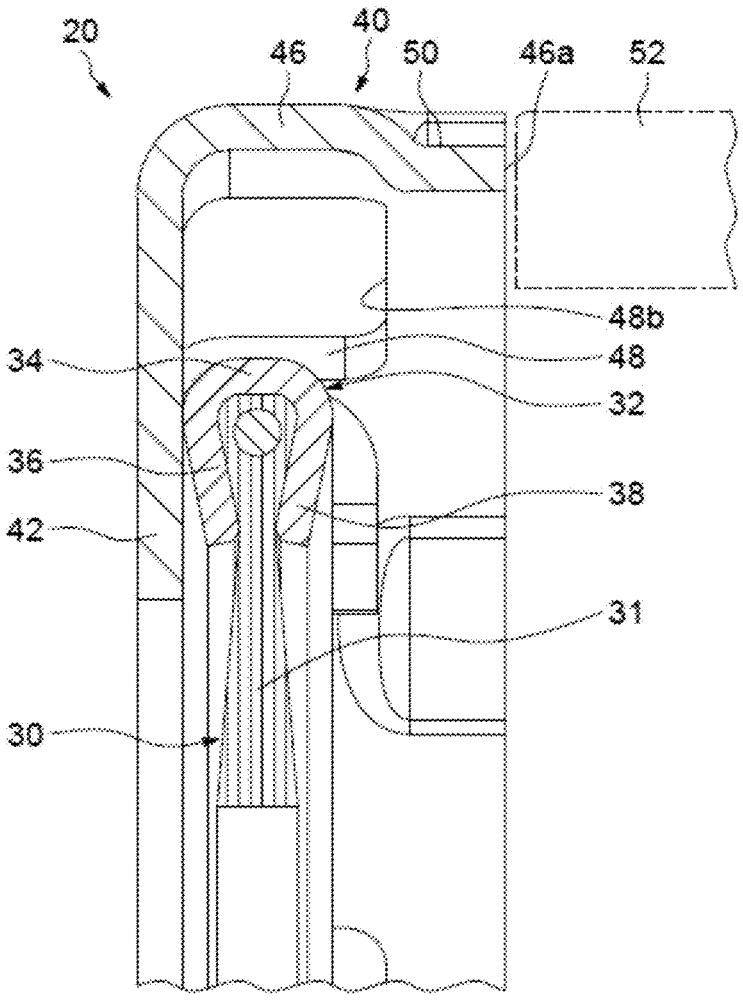


FIG. 7

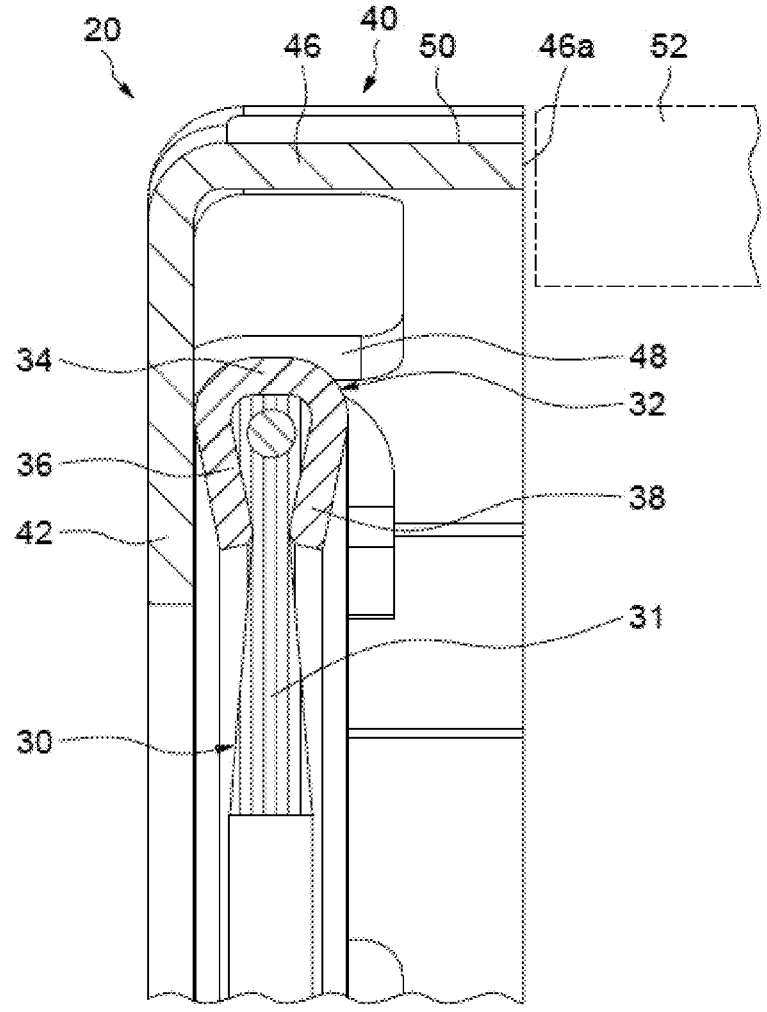


FIG. 8

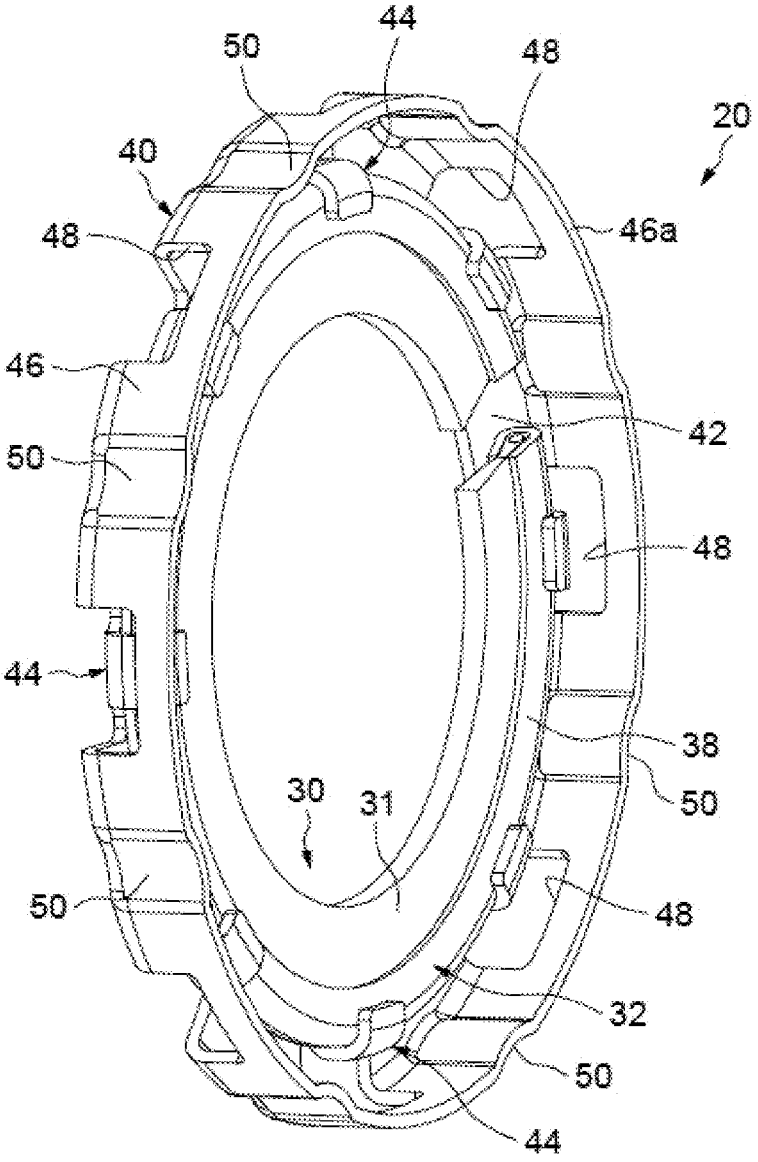


FIG. 9

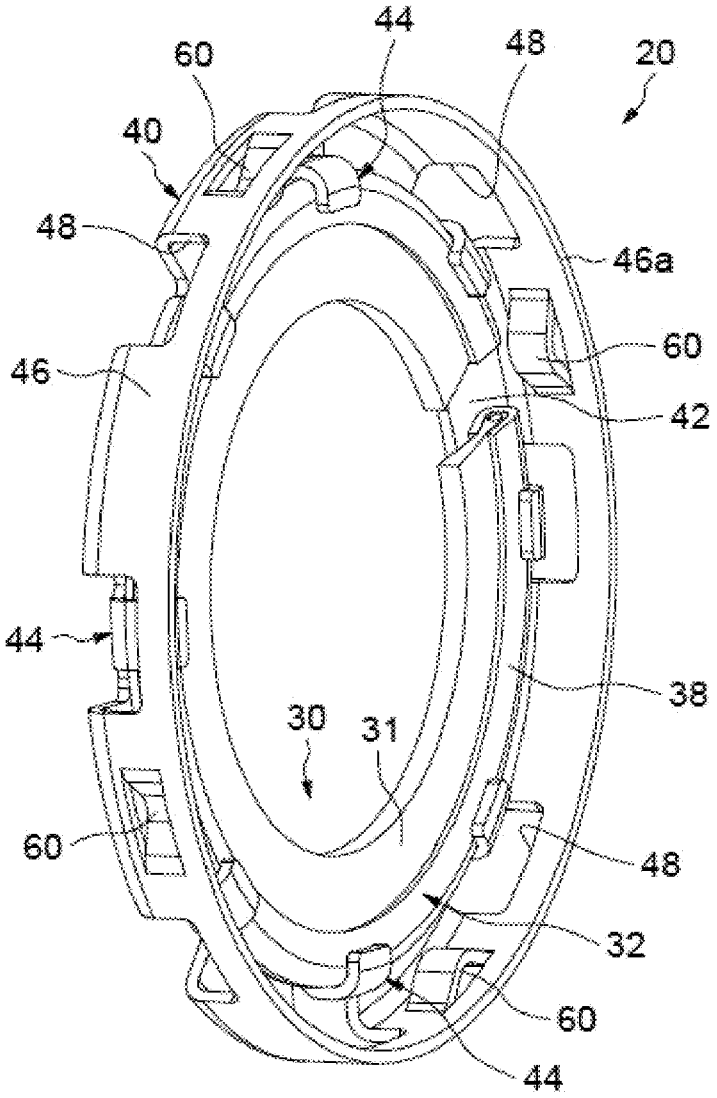


FIG. 10

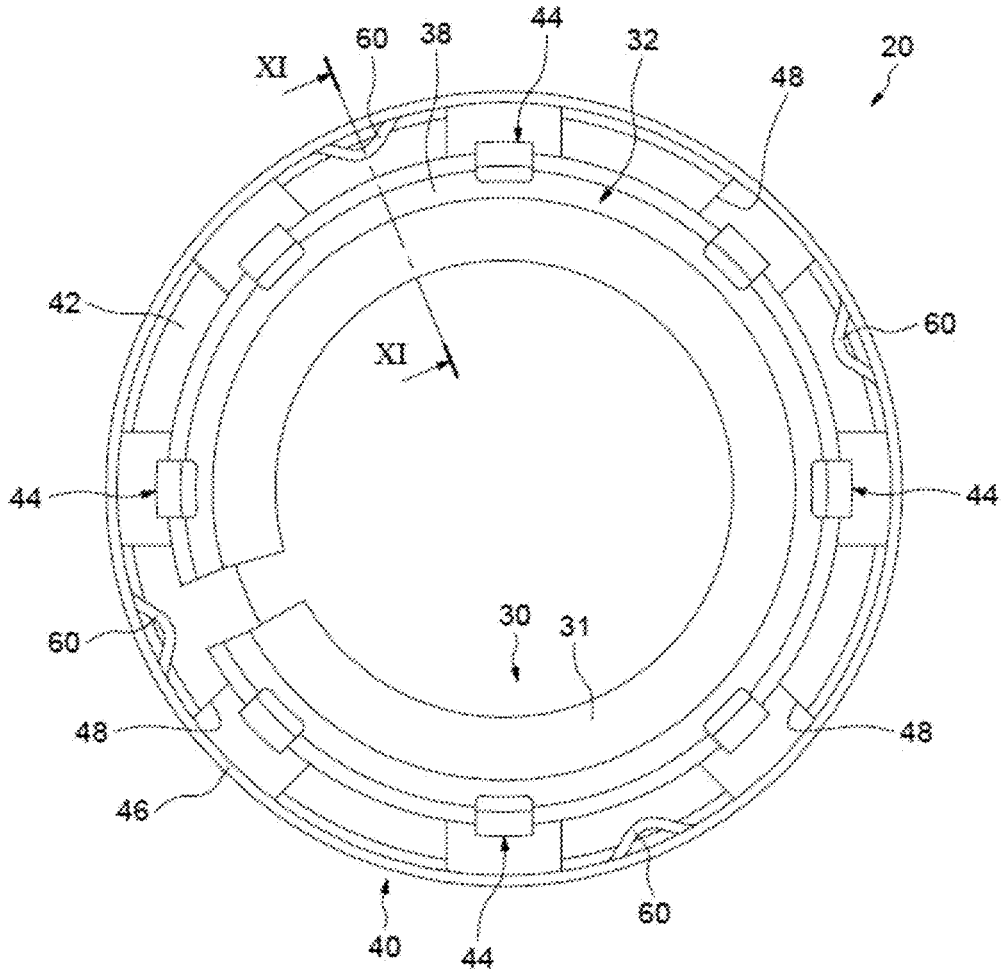
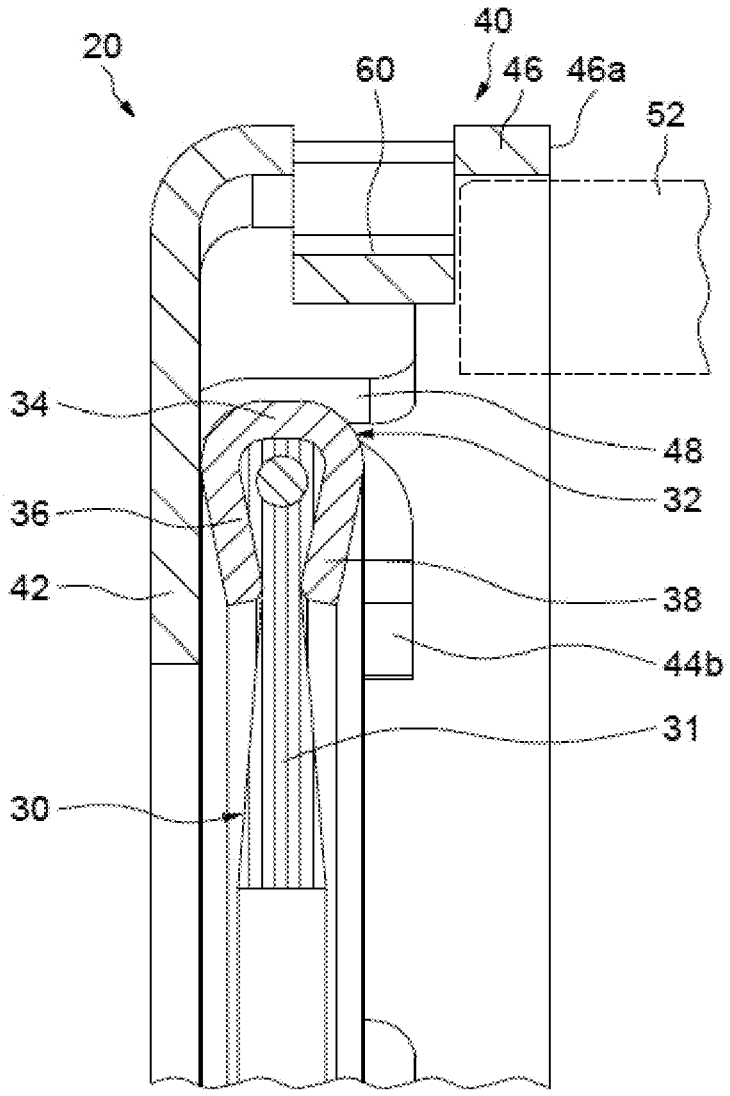


FIG. 11



GROUNDING BRUSH ASSEMBLY

CROSS-REFERENCE

[0001] This application claims priority to French patent application no. 2302819 filed on Mar. 24, 2023, the contents of which are fully incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to grounding devices for controlling shaft current generated in motors or electrical machines, and more particularly to grounding brush assemblies.

[0003] In a motor or electrical machine, at least one roller bearing is fitted between the housing of the motor or electrical machine and a rotary shaft so as to rotatably support the shaft. During motor operation as the shaft rotates, a difference of electrical potential may be arise between the shaft and the housing of the motor or other electrical machine, which can generate a flow of electric current between the inner ring of the roller bearing, connected with the shaft, and the outer ring connected with the housing. Such electric current passing through the components of the roller bearing can damage these components, in particular the rolling elements and the raceways provided on the inner and outer rings. The electrical discharges can also generate vibrations.

[0004] In order to eliminate these disadvantages, it is known to "earth" or ground the rotary shaft by using a brush or a grounding brush comprising conductive fibers. The grounding brush is generally fitted in the bore of the housing of the electric motor, such that the free ends of the fibers are in radial contact with the outer surface of the rotary shaft.

[0005] Due to the conductivity of the fibers, the brush is maintained at the same electrical potential as the housing of the electric motor. The inner and outer rings of the roller bearing are also at the same electrical potential, which reduces or even eliminates the problematic electrical discharges through the roller bearing.

[0006] Such a grounding brush assembly is disclosed in US Patent Publication No. 2021/0021180 A1, which includes a grounding brush provided with a plurality of conductive fibers, a support inside of which the conductive fibers are fitted, and an annular fitting plate. The fitting plate includes a plurality of tongues for radial and axial retention of the support and an annular outer flange surrounding the brush and the tongues radially. These tongues are formed by cutting and plastic deformations of the radial portion of the fitting plate, which is axially supported against the support.

[0007] Generally, to install the brush assembly inside the bore of the housing of the electric motor, a cylindrical tool is used. Such a tool is inserted radially between the support of the brush and the outer flange of the fitting plate and is supported axially against the radial portion of the fitting plate.

[0008] For an electric motor with a relatively small radial space between the housing and the rotary shaft, it is often not possible to place the tool between the support and the flange for installation of the brush assembly. This is due to the reduced radial distance between the flange of the fitting plate and the support and the retention tongues of the fitting plate.

[0009] Further, it is often not possible to support the tool against the free end of the outer flange of the fitting plate as the thickness of the flange is also often reduced due to the radial compactness between the housing and the rotary shaft. Also, it is generally not advisable to push the fitting tool against the end of the retention tongues of the fitting plate of the brush assembly as such exertion could lead to deformation of the support and the conductive fibers of the brush.

[0010] In view of the above, there is a clear need for a grounding brush assembly designed for electric motors in which the radial space between the housing and the rotary shaft is limited.

SUMMARY OF THE INVENTION

[0011] The present invention concerns a grounding brush assembly comprising a grounding brush provided with a plurality of conductive fibers and a support inside of which the conductive fibers are fitted. The assembly also comprises a brush fitting plate which is connected with the support of the brush.

[0012] The fitting plate includes a plurality of retention tongues configured to retain the support of the brush, a radial portion and an annular flange extending from the radial portion. The annular flange is offset radially outwardly from the retention tongues, i.e., offset towards the exterior relative to the retention tongues, and has an outer surface defining the outer diameter of the fitting plate.

[0013] According to a general characteristic, the fitting plate includes a plurality of through-openings which each extend through the radial portion and through the flange.

[0014] According to another general characteristic, at least one local deformation is formed on the fitting flange and extends radially inwardly from a remainder of the flange and towards the interior of the assembly.

[0015] The one or more deformations provide an increase in the local contact surface of the fitting plate for the tool used during the fitting of the brush assembly inside the bore of the housing of the electric motor.

[0016] The deformation(s) thereby limit the risk of deformation of the flange and the fitting plate during installation of the grounding brush assembly. In addition, the axial force applied to the fitting plate is applied in an area spaced from the support and the conductive fibers. The support and the conductive fibers are therefore not deformed during the fitting or installation process.

[0017] With the present solution, it is possible to provide a grounding brush assembly with a radially reduced size.

[0018] In addition, the local deformation of the fitting plate can also fulfill an anti-rotation function for the assembly. Specifically, a protuberance with a corresponding form may be provided on the bore of the housing of the associated electric motor for interacting with the deformation(s).

[0019] Preferably, the at least one local deformation is located circumferentially between two through-openings of the fitting plate. Such positioning of the deformation(s) facilitates the fabrication of the fitting plate.

[0020] According to one embodiment, the one or more local deformations each extends from the free end of the flange of the fitting plate. The local deformation may be formed on a part or portion of a length, i.e., an axial length, of the flange of the fitting plate.

[0021] Alternatively, each local deformation may be formed along the entire axial length of the flange of the fitting plate. Such elongated deformations reinforce the rigidity of the flange.

[0022] According to an alternative embodiment, the local deformation may be axially spaced from the free end of the flange of the fitting plate.

[0023] According to one embodiment, a plurality of local deformations are each formed on the flange of the fitting plate, each local deformation extending radially towards the interior, or radially inwardly, and are offset relative to one another in the circumferential direction, i.e., spaced circumferentially apart.

[0024] According to one embodiment, the retention tongues for retention of the fitting plate extend from the radial portion. Alternatively, the retention tongues may extend from another portion of the fitting plate.

[0025] According to one embodiment, the support and the fitting plate are two distinct parts connected together by the retention tongues. Alternatively, the support and the fitting plate can be produced in a single piece or integrally formed.

[0026] According to one embodiment, the radial portion of the fitting plate is supported axially against the support of the brush. Alternatively, another radial portion of the fitting plate may be supported axially against the support of the brush.

[0027] The present invention also relates to an electric motor comprising a housing, a shaft and at least one grounding brush assembly as previously defined and fitted radially between the housing and the shaft, the conductive fibers of the brush of the assembly being in contact with the shaft.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0028] The present invention will be better understood by studying the detailed description of an embodiment, taken by way of non-limiting example, and illustrated by the appended drawings in which:

[0029] FIG. **1** is an axial cross-sectional view of a grounding brush assembly fitted radially between a rotary shaft and an electric motor housing;

[0030] FIG. **2** is a front perspective view of the grounding brush assembly according to a first embodiment of the present invention;

[0031] FIG. **3** is a rear perspective view of the grounding brush assembly according to the first embodiment of the present invention;

[0032] FIG. **4** is a front plan view of the grounding brush assembly of FIGS. **2** and **3**;

[0033] FIG. **5** is a cross-sectional view along the line V-V of FIG. **4**;

[0034] FIG. **6** is a broken-away axial cross-sectional view along the line VI-VI of FIG. **4**;

[0035] FIG. **7** is an a broken-away, axial cross-sectional view of a grounding brush assembly according to a second embodiment of the invention;

[0036] FIG. **8** is a perspective view of the grounding brush assembly of FIG. **7**;

[0037] FIG. **9** is a perspective view of a grounding brush assembly according to a third embodiment of the invention;

[0038] FIG. **10** is a front plan view of the grounding brush assembly of FIG. **9**; and

[0039] FIG. **11** is a cross-sectional view along the line XI-XI of FIG. **10**.

DETAILED DESCRIPTION OF THE INVENTION

[0040] FIG. **1** diagrammatically depicts or represents in axial cross-section a part of a motor **10** or an electrical machine comprising a fixed housing **12** and a rotary shaft **14** rotatable about an axis X-X, which is supported radially by a roller bearing **16**. As depicted, the roller bearing **16** is a ball bearing, but may have any other type of rolling elements, such as cylindrical rollers, tapered rollers, needles, etc., or may even be formed as a plain bearing.

[0041] The motor **10** also comprises a grounding brush assembly **20** which is fitted radially between the bore **12***a* of the housing **12** and the cylindrical outer surface **14***a* of the rotary shaft **14**. The grounding brush assembly **20** enables a continual dissipation of the electrical charges, which accumulate on the shaft **14** of the motor **10** during the motor operation, by transferring these charges to the housing **12**.

[0042] With reference to FIGS. **2-5**, a description will now be provided of a grounding brush assembly **20** according to a first embodiment. The grounding brush assembly **20** has a generally annular form and basically comprises a grounding brush **30** and a brush fitting plate **40** which is configured to retain the brush **30** both axially and radially.

[0043] The brush **30** includes a plurality of individual conductive fibers **31**, which are designed to be placed or distributed circumferentially around the rotary shaft **14** of the motor **10**. The conductive fibers **31** may be formed of carbon, stainless steel or a conductive plastic, such as acrylic or nylon fibers.

[0044] The brush **30** also comprises a unit **32** for retention or support, hereinafter referred to as a "support" **32**, inside of which the conductive fibers **31** are fitted or disposed. In the illustrated embodiment, the support **32** is in the form of an open ring. The support **32** can be made or fabricated by cutting and stamping. The support **32** is preferably made of an electrically conductive material, such as for example, aluminum, stainless steel, bronze, copper, a conductive plastic or another appropriate conductive material. Alternatively, the support **32** may be made of a non-electrically conductive material provided with a conductive coating or conductive paint.

[0045] As illustrated more clearly in FIG. **5**, the support **32** includes an axial fitting portion **34** and two opposite lateral flanks **36**, **38** each extending radially inwardly from the fitting portion **34** towards the interior, the lateral flanks **36**, **38** axially enclosing the conductive fibers **31**. As such, the conductive fibers **31** are supported axially on both sides against the lateral flanks **36**, **38**.

[0046] The fitting portion **34** and the two lateral flanks **36**, **38** delimit a channel (not indicated) which is open radially on an inner side, the conductive fibers **31** being partly situated or disposed within the channel.

[0047] In the illustrated example, the conductive fibers **31** are folded or bent around a connection wire **39** of the support **32**. The distal free end(s) of each conductive fiber **31** is designed to come into radial contact with the outer surface **14***a* of the rotary shaft **14** of the motor **10**. The proximal end of each conductive fiber **31** is in radial contact with the fitting portion **34** of the support **32**.

[0048] The lateral flank **36** extends radially inwardly from one axial end of the fitting portion **34** and the lateral flank **38** extends radially inwardly from the opposite axial end of the fitting portion **34**. Preferably, the lateral flanks **36**, **38** extend obliquely towards the interior from the fitting portion **34** and

are preferably symmetrical with respect to each other relative to a median radial plane of the support **32**. As depicted, the fitting portion **34** extends axially, but may alternatively extend obliquely. Also, the lateral flanks **36**, **38** may alternatively be asymmetrical.

[0049] The brush **30** is preferably in the form of an open ring comprising a first end which is spaced circumferentially from a second end facing the first end, as shown in FIGS. **2-4**. Such circumferential spacing between the two ends of the brush **30** allows the brush **30** to adapt to different diameters of the motor shaft **14**.

[0050] In general, the first and second circumferential ends of the brush **30** are not secured to one another, but may be in contact with one another. Alternatively, the first end and the second end of the brush **30** may be secured to each other.

[0051] The fitting plate **40** of the brush assembly **20** includes an annular radial portion **42** and a plurality of retention tongues **44** configured to axially and radially retain the brush **30**, the tongues **44** extending from the radial portion **42**. As will be described in greater detail below, the fitting plate **40** also includes an annular flange **46** extending from the radial portion **42**.

[0052] The fitting plate **40** is preferably fabricated by cutting and stamping and is preferably formed of a conductive material, such as for example, aluminum, stainless steel, bronze, copper or another appropriate conductive material. Alternatively, the fitting plate **40** may be formed of a non-electrically conductive material and provided with a conductive coating or a conductive paint.

[0053] The radial portion **42** of the fitting plate **40** is supported axially against the support **32** of the brush **30**. More specifically, the radial portion **42** is supported axially against the lateral flank **36** of the support **32**.

[0054] The retention tongues **44** are spaced from one another in the circumferential direction, i.e., are circumferentially spaced apart, preferably regularly or evenly. Alternatively, the tongues **44** may be circumferentially spaced irregularly or staggered. In the illustrated embodiment, there are eight tongues **44**, but there may alternatively be a greater or lesser number of tongues **44**. Further, it is possible to provide only two tongues **44** or at least four tongues **44**. Preferably, the number of tongues **44** is at least equal to two.

[0055] Each retention tongue **44** extends axially projecting relative to the radial portion **42**. Each tongue **44** locally radially surrounds the support **32** of the brush **30** and is in radial contact with the fitting portion **34** of the support **32**. The support **32** is maintained supported axially against the radial portion **42** of the fitting plate **40** by the tongues **44**. The tongues **44** enable the axial and radial retention of the grounding brush **30**. The lateral flank **36** of the support **32** is supported against the radial portion **42** of the fitting plate **40** and the lateral flank **38** is supported against the tongues **44**. Preferably, the tongues **44** are formed substantially identical to each other.

[0056] Further, each retention tongue **44** includes an axial portion **44***a*, which extends axially from the radial portion **42** and locally radially surrounds and contacts the support **32**, and a radial portion **44***b*. Each radial portion **44***b* is provided at a free end of the axial portion **44***a* and is folded back or bent radially inwardly toward the interior. The folded-back or radial portion **44***b* of each tongue **44** enables the axial retention of the support **32** of the grounding brush **30**. The folded-back/radial portion **44***b* of each tongue **44** is in axial contact against the lateral flank **38** of the support **32**.

[0057] The annular flange **46** of the fitting plate **40** extends axially from a large diameter or outer edge of the radial portion **42**. Preferably, the flange **46** extends axially from the same side of the radial portion **42** as the tongues **44**. Alternatively, the flange **46** may extend axially from a side of the radial portion **42** opposite from the tongues **44**.

[0058] The flange **46** locally radially surrounds and is spaced radially outwardly from the tongues **44**. In other words, the bore of the flange **46** is spaced radially apart from the tongues **44**. The outer surface of the flange **46**, radially opposite the bore of the flange **46**, defines the outer diameter of the fitting plate **40**. The flange **46** assures the centering of the fitting plate **40** after fitting the brush assembly **20** in the bore **12***a* of the housing **12** of the associated electric motor **10**.

[0059] A plurality of through openings **48** are provided in the thickness of the radial portion **42** of the fitting plate **40**. The openings **42** also extend axially on the flange **46**. In other words, each through opening **48** extends both through the radial portion **42** and through the flange **46**. The openings **48** extend locally through the thickness of the radial portion **42** and locally through the thickness of the flange **46**. The openings **48** extend axially on the flange **46** and are spaced from the free end **46***a* of the flange **46**.

[0060] The openings **48** are formed during the partial cutting of the fitting plate **40** to form the tongues **44**. That is, the tongues **44** are formed by cutting, folding and crimping of the fitting plate **40**. The openings **48** are circumferentially spaced apart or spaced from each other in the circumferential direction, preferably regularly or evenly. Each tongue **44** is aligned in the circumferential direction with, i.e., circumferentially aligned with, the associated opening **48**. The number of openings **48** corresponds to the number of tongues **44**.

[0061] As can be seen in particular in FIG. **3**, the root of each tongue **44** extends from an edge **48***a* of the associated opening **48**, which is situated on the radial portion **42**, and extends in the circumferential direction.

[0062] The fitting plate **40** also includes a plurality of local deformations **50**, which are formed on the flange **46**, and extend radially inwardly toward the interior of the brush assembly **20**. Each local deformation **50** is located or positioned circumferentially between two immediately successive openings **48**.

[0063] Each local deformation **50** extends radially towards the interior, i.e., radially inwardly, from the outer surface of the flange **46**. Each local deformation **50** is formed by local forcing back or deforming of the material of the flange **46** radially inwardly or toward the interior of the fitting plate **40**. Each local deformation **50** forms on the flange **46** a depression or hollow which is oriented radially outwardly or towards the exterior. The local deformations **50** do not open radially onto the bore of the flange **46**. Each local deformation **50** projects inwardly toward the interior relative to the remainder of the flange **46** which is not deformed.

[0064] In the illustrated embodiment, each local deformation **50** extends axially from the free end **46***a* of the flange **46**. Each local deformation **50** preferably extends axially along a portion of the axial length of the flange **46**. As such, each local deformation **50** is axially spaced from the radial portion **42**. Each deformation **50** extends axially beyond an

edge **48***b* of the opening **48** which is situated on the flange **46**, and extends in the circumferential direction.

[0065] In the depicted examples, the local deformations **50** are substantially identical to each other. The local deformations **50** are circumferentially spaced apart or spaced from one another in the circumferential direction, in this case regularly or evenly. Alternatively, the deformations **50** may be irregularly or unevenly circumferentially spaced. In the illustrated embodiment, there are eight deformations **50**. Alternatively, there may be a greater or lesser number of deformations **50**. It is possible to provide only a single deformation **50**, at least two deformations **50** located diametrically opposite, at least four deformations **50**, etc.

[0066] In order to fit or install the grounding brush assembly **20** inside the bore **12***a* of the housing **12** of the associated electric motor **10**, a cylindrical fitting tool **52** is preferably used, represented partly in broken lines in FIG. **6**, which is positioned so as to be supported axially against the free end **46***a* of the flange **46**, in order to be able to thrust or push the brush assembly **20** axially.

[0067] The local deformations **50** increase the contact surfaces between the flange **46** of the fitting plate **40** and the tool **52**, which facilitates fitting or installation of the brush assembly **20** within the housing **12** of the associated electric motor **10**, and without deformation of the support **32** and the conductive fibers **31**.

[0068] The embodiment illustrated in FIGS. **7** and **8**, in which elements that are identical are indicated by the same reference numbers, differs from the first depicted example in that the local deformations **50** of the fitting plate **40** extend axially along the entire axial length of the flange **46**. The local deformations **50** extend from the free end **46***a* of the flange **46** as far as the radial portion **42**.

[0069] In the first two illustrated embodiments, the local deformations **50** of the fitting plate **40** extend from the free end **46***a* of the flange **46**. Alternatively, the local deformations **50** of the fitting plate **40** may be spaced axially from the free end **46***a* of the flange **46**, as in the embodiment illustrated in FIGS. **9-11**, in which identical elements bear the same reference numbers.

[0070] Similarly to the first examples, the local deformations **60** are formed on the flange **46** so as to extend radially inwardly or toward the interior, and do not open radially onto the bore of the flange **46**. In this embodiment, the deformations **60** are open on both axial sides. Alternatively, depending on the radial dimension of the deformations **60**, the deformations may be closed on one or both of the axial sides of the deformation **60**.

[0071] Similarly to the first examples, each local deformation **60** extends radially inwardly toward the interior from the outer surface of the flange **46**. Each local deformation **60** is formed by local forcing back or deforming of the material of the flange **46**, radially inwardly toward the interior. Each local deformation **60** forms a depression or hollow on the flange **46** that is oriented radially towards the exterior, i.e., faces radially outwardly. Each local deformation **60** projects radially inwardly toward the interior relative to the remainder of the flange **46** which is not deformed.

[0072] The local deformations **60** are formed on the flange **46** and are axially spaced from both the free end **46***a* of the flange **46** and from the radial portion **42**. Each local deformation **60** is situated or positioned circumferentially between two immediately successive openings **48**. In the depicted embodiment, the local deformations **60** are substantially identical to each other. Further, the local deformations **60** are circumferentially spaced apart, preferably regularly or evenly. Alternatively, the deformations **60** may be irregularly or unevenly circumferentially spaced apart. In the illustrated embodiment, there are four deformations **60**. Alternatively, it is possible to provide a different number of deformations **60**.

[0073] In order to install or fit the grounding brush assembly **20** inside of the bore **12***a* of the housing **12** of the associated electric motor **10**, the tool **52** is positioned against or supported axially on the deformations **60** of the fitting plate **40** so as to thrust or push the assembly **20** axially.

[0074] In the embodiments described, the fitting plate **40** is produced by cutting and stamping, and the local deformations **50**, **60** are formed by local forcing back or deforming of the material of the flange **46**.

[0075] Alternatively, the fitting plate **40** may be fabricated by means of other production processes, for example additive production, i.e., by any production process which is based on the construction of the fitting plate layer by layer by addition of material. In this case, the local deformations are obtained during the production of the fitting plate **40**. Further for example, the fitting plate **40** may be formed by casting, forging or molding, in which the local deformations **50**, **60** are formed along with the remainder of the fitting plate **40**.

[0076] Representative, non-limiting examples of the present invention were described above in detail with reference to the attached drawings. This detailed description is merely intended to teach a person of skill in the art further details for practicing preferred aspects of the present teachings and is not intended to limit the scope of the invention.

[0077] Moreover, combinations of features and steps disclosed in the above detailed description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe representative examples of the invention. Furthermore, various features of the above-described representative examples, as well as the various independent and dependent claims below, may be combined in ways that are not specifically and explicitly enumerated in order to provide additional useful embodiments of the present teachings.

[0078] All features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter, independent of the compositions of the features in the embodiments and/or the claims. In addition, all value ranges or indications of groups of entities are intended to disclose every possible intermediate value or intermediate entity for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter. The invention is not restricted to the above-described embodiments, and may be varied within the scope of the following claims.

We claim:

1. A grounding brush assembly comprising:

a grounding brush including a support and a plurality of conductive fibers fitted inside the support; and

a brush fitting plate connected with the support of the brush and including a plurality of retention tongues configured to retain the support, a radial portion, an annular flange extending from the radial portion and offset radially outwardly from the plurality of retention

tongues, the annular flange having an outer surface defining the outer diameter of the fitting plate, a plurality of through-openings which each extend through the radial portion and through the flange, and at least one local deformation formed on the flange and extending radially inwardly.

2. The assembly according to claim **1**, wherein the at least one local deformation is disposed circumferentially between two of the plurality of through-openings of the fitting plate.

3. The assembly according to claim **1**, wherein the at least one local deformation extends axially from the free end of the flange of the fitting plate.

4. The assembly according to claim **1**, wherein the at least one local deformation is formed on a portion of an axial length of the flange of the fitting plate.

5. The assembly according to claim **1**, wherein the at least one local deformation is formed on an entire axial length of the flange of the fitting plate.

6. The assembly according to claim **1**, wherein the at least one local deformation is axially spaced from a free end of the flange of the fitting plate.

7. The assembly according to claim **1**, wherein the at least one local deformation includes a plurality of local deformations formed on the flange of the fitting plate, each one of the plurality of local deformations extending radially inwardly and the plurality of local deformations being circumferentially spaced apart.

8. The assembly according to claim **1**, wherein the plurality of retention tongues of the fitting plate extend from the radial portion of the fitting plate.

9. The assembly according to claim **1**, wherein the radial portion of the fitting plate is supported axially against the support of the brush.

10. An electric motor comprising:

a housing;

a shaft; and

at least one grounding brush assembly according to claim **1** fitted radially between the housing and the shaft, the conductive fibers of the brush of the grounding brush assembly being in contact with the shaft.

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